

CLAIMS

*What is claimed is:*

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1. A gas purification system providing hydrogen sorption and particle filtering, said gas purification system comprising:

a) a hydrogen sponge including hydrogen sorption material;

b) a particle filtering device; and

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c) an enclosure having an inlet and an outlet, said enclosure housing said hydrogen sponge and said particle filter device, said hydrogen sponge proximal to said inlet, said particle filter device being proximal to said outlet, said hydrogen sponge and said particle filter device arranged within said enclosure such that a gas flowing into said enclosure via said inlet and out of said enclosure via said outlet, must follow a flow path first contacting said hydrogen sorption material and then flowing through the particle filtering device.

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2. A gas purification system as recited in claim 1, wherein the particle filtering device is manufactured from a sintered metal.

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3. A gas purification system as recited in claim 1, wherein the particle filtering device is substantially capable of removing particles from said outlet gas flow as small as 0.003 micron.

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4. A gas purification system as recited in claim 2, wherein the particle filtering device is manufactured from at least one of: nickel, stainless steel.

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5. A gas purification system as recited in claim 2, wherein the particle filtering device is comprised of a plurality of filtering elements.

6. A gas purification system as recited in claim 5, wherein the filtering element has a conical shape.

5 7. A gas purification system as recited in claim 5, wherein the filtering element is a disk shape.

8. A gas purification system as recited in claim 1, wherein the hydrogen sorption material is selected from the group consisting of: zirconium, palladium, platinum, rhodium, ruthenium, nickel, titanium and alloys thereof.

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9. A gas purification system as recited in claim 1, wherein the hydrogen sorption material comprises a non-evaporative getter alloy selected from the group consisting of: zirconium-vanadium-iron alloys and zirconium-iron alloys.

15 10. A gas purification system as recited in claim 1, further comprising a temperature measuring device.

11. A method for purifying a gas, the method suitable for purifying gas to a level of purity sufficient for semiconductor manufacturing, the method comprising the acts of:

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- a) cooling the gas to less than 100 degrees C.
- b) flowing the gas under pressure into a gas purification system enclosure via an inlet;
- c) contacting said gas under pressure with a hydrogen sponge disposed within said gas purification system enclosure;
- d) flowing said gas through a particle filtering device disposed within said gas purification system enclosure; and
- e) flowing said gas out of said gas purification system enclosure via an outlet.

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12. A method for purifying a gas as recited in claim 11, wherein the particle filtering device is manufactured from a sintered metal.

13. A method for purifying a gas as recited in claim 11, wherein the particle filtering device is substantially capable of removing particles from said outlet gas flow as small as 0.003 micron.

14. A method for purifying a gas as recited in claim 12, wherein the particle filtering device is manufactured from at least one of: nickel, stainless steel.

15. A method for purifying a gas as recited in claim 12, wherein the particle filtering device is comprised of a plurality of filtering elements.

16. A method for purifying a gas as recited in claim 15, wherein the filtering element is a cylindrical shape.

17. A method for purifying a gas as recited in claim 15, wherein the filtering element is a disk shape.

18. A method for purifying a gas as recited in claim 11, wherein the hydrogen sorption material is selected from the group consisting of: zirconium, palladium, platinum, rhodium, ruthenium, nickel, titanium and alloys thereof.

19. A method for purifying a gas as recited in claim 11, wherein the hydrogen sorption material comprises a non-evaporative getter alloy selected from the group consisting of: zirconium-vanadium-iron alloys and zirconium-iron alloys.

20. A method for purifying a gas as recited in claim 11, further comprising the act of monitoring the temperature of the hydrogen sorption material.



21. A heated getter vessel comprising:

- a) a gas heating device;
- b) a quantity of gas purification material;
- 5 c) a quantity of barrier material;
- d) an enclosure having an inlet and an outlet, said enclosure housing said gas purification material and said gas heating device, said gas heating device proximal to the inlet, said barrier material proximal to said outlet, said gas purification material disposed between said gas heating device and said
- 10 barrier material, said gas heating device, gas purification material and said barrier material arranged within said enclosure such that a gas flowing into said enclosure via said inlet and out of said enclosure via said outlet, must follow a flow path first through said gas heating device, then contacting said gas purification material and then flowing through said barrier material.

15 22. A heated getter vessel as recited in claim 21, wherein the gas heating device includes:

- a) a gas heater body;
- b) a heat source;
- 20 c) a plurality of gas passages;
- d) a first annular volume;
- e) a second annular volume, wherein, said gas heater body, said plurality of gas passages, said first annular volume and said second annular volume are arranged within said getter vessel such that said gas heater body defines
- 25 said first and said second annular volumes, said plurality of gas passages are in fluid communication with said inlet and said first annular volume, said first annular volume is in fluid communication with said second annular volume, said second annular volume is in fluid communication with an internal volume defined by said getter vessel enclosure, such that a gas
- 30 flowing into said enclosure via said inlet flows from said inlet then through said plurality of gas passages, then through said first annular volume, then

through said second annular volume and exits said gas heating device into said getter vessel enclosure.

23. A heated getter vessel as recited in claim 22, wherein said heat source includes a plurality of heat sources.

24. A heated getter vessel as recited in claim 23, wherein said plurality of heat sources includes at least one heat source in contact with at least a portion of the gas heater body.

25. A heated getter vessel as recited in claim 23, wherein said plurality of heat sources includes at least one heat source in contact with at least a portion of the getter vessel enclosure.

26. A heated getter vessel as recited in claim 21, wherein said quantity of gas purification material includes a plurality of types of gas purification material.

27. A heated getter vessel as recited in claim 21, wherein the gas purification material is selected from the group consisting of: zirconium, palladium, platinum, rhodium, ruthenium, nickel, titanium and alloys thereof.

28. A heated getter vessel as recited in claim 21, wherein the gas purification material comprises a non-evaporative getter alloy selected from the group consisting of: zirconium-vanadium-iron alloys and zirconium-iron alloys.

29. A heated getter vessel as recited in claim 21, wherein said quantity of barrier material includes a quantity of stainless steel shot.

30. A heated getter vessel as recited in claim 21 further comprising a temperature sensor disposed in a portion of said purification material.

31. A heated getter vessel as recited in claim 20, wherein said temperature sensor is operable to detect a temperature rise of 10 degrees per millisecond.
- 5 32. A heated getter vessel as recited in claim 20, further comprising an outlet filter proximal to outlet of said getter vessel.
- 10 33. A heated getter vessel as recited in claim 32, wherein said outlet filter includes at least one of: a sintered stainless steel filter, a sintered Nickel filter.
34. A heated getter vessel as recited in claim 32, wherein said outlet filter includes at least one of: a disk shaped filter, a cylindrical shaped filter.
- 15 35. A method for purifying a gas, the method comprising the acts of:  
purifying a gas within a heated getter vessel to obtain a purified gas including the acts of:  
a) heating a gas with a gas heating device;  
b) contacting said heated gas to a quantity of gas purification material wherein, said gas purification material is operative to substantially remove  
20 impurities from said heated gas;  
c) providing a barrier layer, wherein said barrier layer having a quantity of barrier material operative to react with a portion of said gas purification material; and  
d) measuring said heated gas temperature utilizing a temperature sensor  
25 disposed in at least a portion of said purification material.
36. A gas purification system comprising:  
a) a system inlet and a system outlet;  
b) a gas to gas heat exchanger having a cool gas inlet, a preheated gas  
30 outlet, a heated gas inlet and a precooled gas outlet;  
c) a heated getter vessel having an inlet, an outlet and a heat source;

- d) a gas to air heat exchanger having a precooled gas inlet and a cooled gas outlet;
  - e) an integrated hydrogen sorption and particle filter having an inlet and an outlet;
  - 5 f) said system inlet in fluid communication with said cool gas inlet on said gas to gas heat exchanger;
  - g) said preheated gas outlet on said gas to gas heat exchanger in fluid communication with said inlet on said heated getter vessel;
  - h) said outlet on said heated getter vessel in fluid communication with  
10 said heated gas inlet on said gas to gas heat exchanger;
  - i) said precooled gas outlet on said gas to gas heat exchanger in fluid communication with said precooled gas inlet on said gas to air heat exchanger;
  - j) said cooled gas outlet on said gas to air heat exchanger in fluid  
15 communication with said inlet on said integrated hydrogen sorption and particle filter; and
  - k) said outlet on said integrated hydrogen sorption and particle filter in fluid communication with said system outlet.
- 20 37. A gas purification system as recited in claim 36, wherein said heated getter vessel includes:
- a) a gas heating device;
  - b) a quantity of gas purification material;
  - c) a quantity of barrier material;
  - 25 d) an enclosure having an inlet and an outlet, said enclosure housing said gas purification material and said gas heating device, said gas heating device proximal to the inlet, said barrier material proximal to said outlet, said gas purification material disposed between said gas heating device and said barrier material, said gas heating device, gas purification material and said  
30 barrier material arranged within said enclosure such that a gas flowing into said enclosure via said inlet and out of said enclosure via said outlet, must



follow a flow path first through said gas heating device, then contacting said gas purification material and then flowing through said barrier material.

38. A gas purification system as recited in claim 36, wherein said integrated hydrogen sorption and particle filter includes:
- a) a hydrogen sponge including hydrogen sorption material;
  - b) a particle filtering device; and
  - c) an enclosure having an inlet and an outlet, said enclosure housing said hydrogen sponge and said particle filter device, said hydrogen sponge proximal to said inlet, said particle filter device being proximal to said outlet, said hydrogen sponge and said particle filter device arranged within said enclosure such that a gas flowing into said enclosure via said inlet and out of said enclosure via said outlet, must follow a flow path first contacting said hydrogen sorption material and then flowing through the particle filtering device.